Urea-formaldehyde Polymerization

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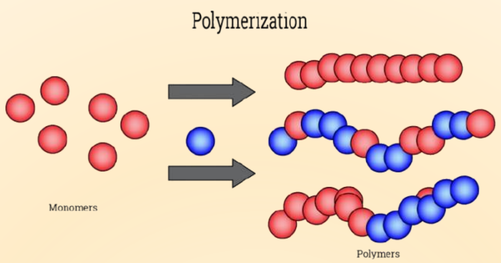
INTRODUCTION



How can we efficiently generate urea-formaldehyde polymers applying modern spectroscopic and microscopic to better understand the kinetics of formaldehyde polymerization in circumstances?

BACKGROUND

Starts from the direct air capture of CO2, followed by photocatalytic conversion into formaldehyde, and then polymerizing it into urea-formaldehyde.

MOTIVATION

- Improve our understanding of carbon fixation and polymer synthesis from ambient CO2.
- Reduce carbon emissions and global warming while developing new materials for the construction.

RESEARCH

CHEMICALS

- Urea (U, H_2NCONH_2)
- Formaldehyde solution (F, CH_2O, 37% weight in H_2O, contains 10–15 % methanol as stabilizer
- Triethanolamine (TEA, N $(C_2H_4OH)_3$)
- Sulfuric acid (H_2SO_4) high concentration.

UREA : FORMALDEHYDE RATIO

Urea (mL)	Formaldehyde (mL)
20	40
10	20
5	10
2.5	5
1.25	2.5
0.625	1.25

PROTOCOLS

Preparation of UF prepolymer

1. Urea (U) and formaldehyde solution (F) were added in a flask with a molar ratio of n(U):n(F) =1:2.
2. When urea is fully dissolved, add triethanolamine (TEA) to the solution until the pH value of the mixture was close to 9.
3. Then, keep the mixture at 70 ◦C under magnetic stirring for 1 hour.

Polymerization of the UF prepolymer

1. Adjusting the pH with H_2SO_4 (around 4 - 4.5)
2. Increasing the temperature to 100°C in 4 hours

FUTURE WORK

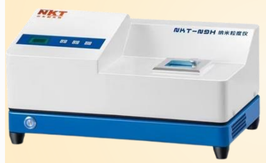
- *Change amount of formaldehyde to see smallest amount that could produce UF polymer.*
- *Raise the temperature to see how fast it would take to create polymers.*

CHARACTERIZE

❑ **Fourier Transform Infrared (FTIR) Spectroscopy:**
Identify the functional groups present in polymer and confirm the formation of the expected chemical structure.

❑ **Thermal Gravimetric Analysis (TGA)**
This technique provides thermal properties, such as the onset of degradation, weight loss, and residual content.

❑ **Dynamic Light Scattering (DLS)**



Measure the particle size and size distribution of the polymer particles of the urea- formaldehyde polymer.

ACKNOWLEDGE

1. Shi, T., Livi, S., Duchet-Rumeau, J., & Gerard, J.-F. (2024). Design of self-healable epoxy-amine-ionic liquid thermosets using poly(urea-formaldehyde) microcapsules containing epoxy prepolymer. *European Polymer Journal*, *215*, 113233.
2. Prof. Dorsa Parviz, lab members

FURI

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